



## Development of 3 D-graphene for Biofuel Cells

Wagner, Michal; Ulstrup, Jens; Zhang, Jingdong

*Publication date:*  
2015

*Document Version*  
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

*Citation (APA):*

Wagner, M., Ulstrup, J., & Zhang, J. (2015). *Development of 3 D-graphene for Biofuel Cells*. Abstract from The 6th International Conference on Carbon for Energy Storage/Conversion and Environment Protection, Poznan, Poland.

---

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

# Development of 3D-graphene for Biofuel Cells

Michal Wagner, Jens Ulstrup and Jingdong Zhang\*

*Department of Chemistry, Technical University of Denmark  
2800 Lyngby, Denmark*

*\*jz@kemi.dtu.dk*

A single, 2 dimensional (2D)-layer of graphite, graphene has attracted significant attention due to its unique structural and physical properties. Graphene is an ideal electrode material due to high electronic conductivity, high surface area, mechanical strength and low mass density [1-3]. High porosity and low density combined with electronic conductivity is desirable in materials for energy storage (supercapacitors and batteries) and energy conversion such as fuel cells. 3D-graphene is a compact network of 2D-graphene structures and has recently gained other attention in these contexts [4-6]. Their porous structures with huge surface area have enhanced charge transport and storage capacities [4], highly important in fuel cells, as large amounts of catalysts can be loaded. This is essential to obtain high power density in the fuel cells. As one type of fuel cells, biofuel cells rest on the use of enzymes or even whole living organisms as catalysts [7]. Major advantages of biofuel cells are that no noble metals are needed and that they operate at ambient temperatures and neutral pH, opening for “green” energy technology.

Our work aims at chemical synthesis and use of microporous 3D-graphene foams. Chemical synthesis is *via* hydrothermal reduction. Architectures are analyzed by microscopic and electrochemical methods. Immobilization of enzymes will be achieved using linker molecules or activation of the graphene surface. We expect that 3D-graphene foams in biofuel cells will greatly enhance enzyme loading and stability. Proper choice of materials and device design offer increased power and current density, extended open-circuit voltage range, and low cost. This could make graphene-based biofuel cells competitive with other, more common catalyst nanomaterials such as carbon nanotubes or metallic nanoparticles.

## Literature:

- [1] K. S. Novoselov, A. K. Geim, S. V. Morozov, D. Jiang, Y. Zhang, S. V. Dubonos, I. V. Grigorieva and A. A. Frisov, *Science* (2004) 306, 666–669.
- [2] D. A. C. Brownson and C. E. Banks, *Analyst* (2010) 135, 2768–2778.
- [3] G. Lopez-Polin, C. Gomez-Navarro, V. Parente, F. Guinea, M. I. Katsnelson, F. Perez-Murano and J. Gomez-Herrero, *Nature Physics* (2015) 11, 26–31.
- [4] W. Wang, S. Guo, M. Penchev, I. Ruiz, K. N. Bozhilov, D. Yan, M. Ozkan and C. S. Ozkan, *Nano Energy* (2013) 2, 294–303.
- [5] H. Ji, L. Zhang, M. T. Pettes, H. Li, S. Chen, L. Shi, R. Piner and R. S. Ruoff, *Nano Letters* (2012) 12, 2446–2451.
- [6] T. Maiyalagan, X. Dong, P. Chen and X. Wang, *Journal of Materials Chemistry* (2012) 22, 5286–5290.
- [7] M. Holzinger, A. Le Goff and S. Cosnier, *Electrochimica Acta* (2012) 82, 179–190.